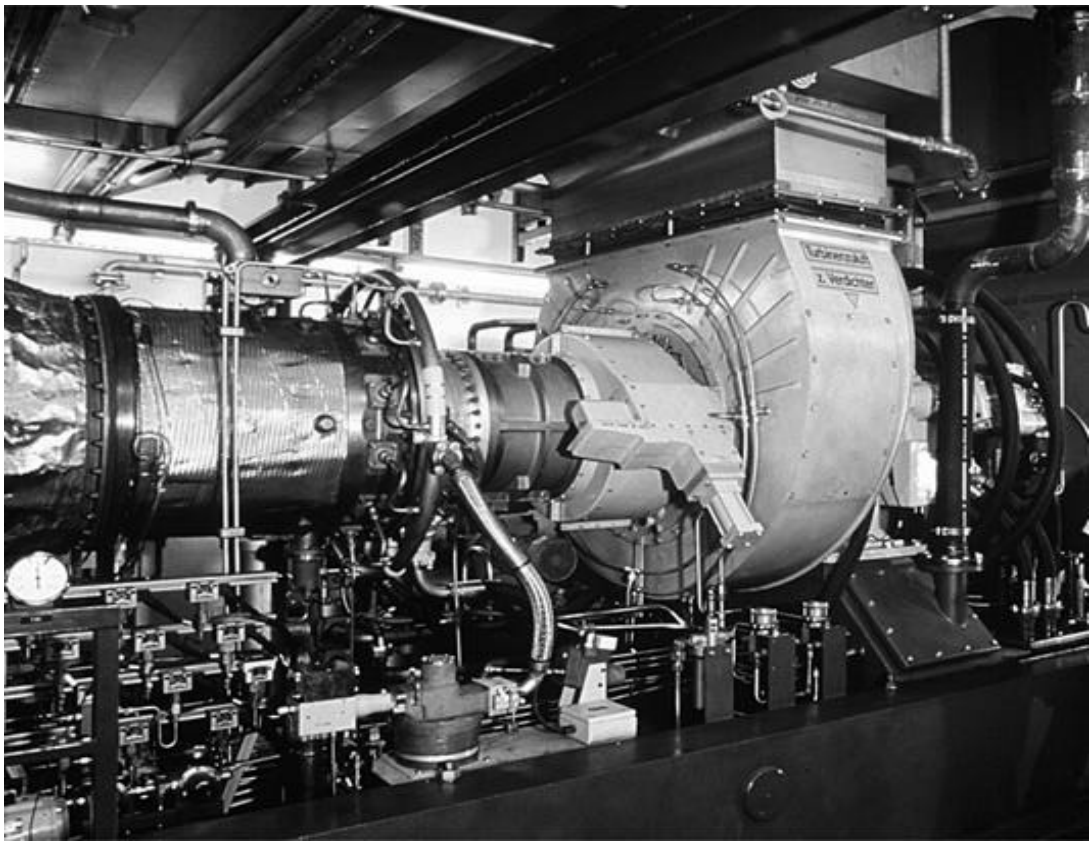
United States Environmental Protection Agency | Air and Radiation 6202J | Draft November 1998

EPA Coalbed Methane Outreach Program Technical Options Series

GENERATING ELECTRICITY USING COAL MINE METHANE-FUELED TURBINES



Gas turbines are a low-cost electricity production option when inexpensive gas is available
(Photo courtesy of Solar Turbines Incorporated)

APPLICATIONS AND BENEFITS INCLUDE...

- Off-grid self-generation of electricity at remote gas production sites
- Wide range of sizes available, from 500 kW to 25 MW
- Ability to use with cogeneration and combined cycle technologies
- Ideal for gob gas use, as they can operate on gas with a heating value as low as 350 Btu
- Recovery and use of methane reduces greenhouse gas emissions
- Reliable and proven technology

Gas turbine technology is proven and reliable

Why Consider Using Coal Mine Methane to Fuel Gas Turbines for Electricity Generation?

A large portion of the methane emitted from coal mines comes from gob areas (collapsed rock over mined out coal), where methane concentrations typically vary from 30 to 80%. Gas with a methane concentration less than 95% is usually not suitable for pipeline injection. As a result, coal mines frequently do not use this medium-quality gas and instead vent it to the atmosphere, contributing to global warming. However, gas with a methane concentration exceeding 35% (such as coal mine gas) can in fact be used as fuel for on-site electricity generation.

The use of gas turbine technology for electricity generation is proven and reliable, and coal mines in Germany, Great Britain, Japan, China and Australia have successfully used coal mine methane-fueled gas turbines. Multiple gas turbine configurations designed to meet specific efficiency and application requirements are available. These include turbines capable of running on gob gas with variable methane concentrations, turbines with low NO_x emissions, and those capable of waste heat recovery for cogeneration and combined cycle applications.

Gas turbine exhaust can be used with cogeneration and combined cycle technology

In recent years manufacturers have made many improvements in the materials used in turbine parts. These improvements result in greater efficiencies, longer service life, and lower overall maintenance costs. Turbines using medium quality (35% to 75% methane) fuel are currently available. At least one manufacturer is developing a gas turbine capable of using low quality fuel (< 7.5% methane). In the future, gas turbines capable of using fuel with such a low heating value may be able to run on enriched coal mine ventilation air.

Installed costs for gas turbines suitable for coal mine use range from $650/kWh to $1000/kWh. The largest operating cost is fuel, which can be minimized by using gob gas. It may be possible to realize further savings by using mine ventilation air for combustion air in the turbine. Assuming a purchase price of $0.04 /kWhr for electricity from a utility, a coal mine generating its own electricity could save $1 million per year for each 5 MW of utilized generation capacity.

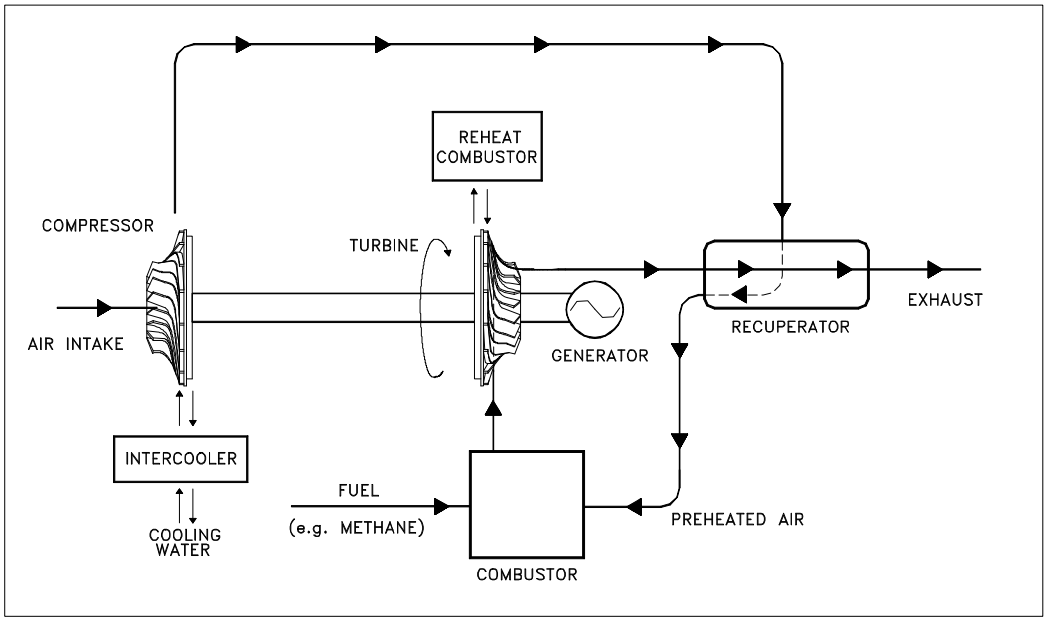
In today's changing power market, the trend toward distributed generation will allow consumers to determine their own power generation sources. Gas turbines may be a good choice for coal mines with unutilized methane resources. Many turbine manufactures have training programs, maintenance agreements and lease options available to turbine purchasers. In many cases, a coal mine may be able to realize substantial savings by using coal mine methane to generate electricity on-site.

SOME FACTS ABOUT GAS TURBINES…

- Mines can recover exhaust energy for heating buildings or drying coal
- Modular design allows for easy installation
- Trailer mounted units permit flexibility in siting and fast installation
- "Medium btu" turbines normally operate over a range of 35% to 75% methane

Gas turbines have a low energy density (output to size ratio)

HOW A GAS TURBINE OPERATES



Gas turbine operation is a relatively simple process. First, a pressure gradient draws air into a compressor stage in the turbine. An intercooler at this stage increases compressor efficiency by cooling the intake air, thereby increasing its density. The compressed air exits the compressor stage through an exhaust heat recuperator, which preheats the compressed air to increase combustion efficiency. The preheated compressed air is then mixed with fuel and combusted. The resulting hot gas expands through the turbine, producing the mechanical energy required to generate electricity and operate the compressor stage of the turbine. Some turbines use a reheat combustor to maximize the combustion and expansion of the gas through the turbine. The hot exhaust gas is then passed through the heat recuperator to preheat the incoming compressed air.

Comparison Of Gas Turbines With Other Power Generation Technologies

	GAS TURBINE	MICRO TURBINE	IC ENGINE	FUEL CELL
Capacity (kW)	1000-50000	30-2000	10-4000	3-3000
Efficiency	21%-42%	22%-30%	12%-20%	40%-65%
Typical Installed Cost ($US/kW)	650-1000	350-700	600-1000	900-3000
Maintenance cost ($US/kWhr)	0.003-0.008	0.003-0.01	0.015-0.025	0.005-0.01

For More Information...

Rapidly changing electricity markets are creating new opportunities for on-site power generation using coal mine methane. Gas turbines may be a cost-effective power generation option for some gassy underground coal mines.

To obtain more information about generating electricity using gas turbines, contact:

Ken Berg
Solar Turbines, Incorporated
600 East Crescent Avenue, Suite 305
Upper Saddle River, NJ 07458
Telephone: (201) 825-8200
Fax: (201) 825-8454

There are also many other gas turbine manufacturers worldwide. The Internet site **www.gasturbines.com** maintains an extensive list of gas turbine manufacturers, including contact information, specifications and prices.

Or contact EPA's Coalbed Methane Outreach Program for information about this and other profitable uses for coal mine methane:

Coalbed Methane Outreach Program
U.S. EPA (6202J)
401 M Street , SW
Washington, DC 20460 USA
(202) 564-9468 or 564-9481
Fax: (202) 565-2077
e-mail: fernandez.roger@epa.gov
schultz.karl@epa.gov

http://www.epa.gov/coalbed

EPA
COALBED METHANE OUTREACH PROGRAM